articular cartilage in late-stage disease, leaving a footprint of multiple tidemarks as the mineralization front advances. These findings can be detected histologically whereas MR assessment becomes challenging, due to size (width) and the tissues rapid relaxation time. The aim of this study was to compare a quantitative T2*, thickness of CC and OJ using vTE at 3T and 7T, as well as to correlate with histomorphometry.

Methods: Six ex-vivo human knees were used in the study (mean age 76 +/- 7 years). The ex-vivo knees were examined with a 3T whole-body system (Tim-Trio, Siemens Healthcare, Erlangen, Germany) and 7T investigational whole body system (Magnetom 7Tesla, Siemens Healthcare, Erlangen, Germany) using similar 8-channel knee coils. T2* maps were calculated from an isotropic 3D multi-echo vTE-sequence using ten sequentially shifted echo times TE =[0.75, 3.51, 5.87, 8.23, 10.6, 12.96, 15.33, 17.69, 20.06, 22.42] ms using a mono-exponential fit least square analysis performed in IDL 6.3 (Interactive Data Language, Research Systems, Inc, Boulder, CO, USA). The fitting function was S=S0×e-TE/T2* + offset, where offset was estimated from the TE=0.75ms image noise. The thickness measurements were performed on subtracted vTE images with TE=0.75ms and TE=22.42ms with highlighted fast relaxing tissues (optimized for T2* in range of 1 to 10 ms) in JiveX software (JiveX 4.3, VISUS Technology Transfer GmbH, Bochum, Germany). Regions of Interest (ROI) on femoral condyle cartilage (medial and lateral) were drawn on the weight-bearing zone and transferred to T2* maps. Sagittal sections were stained with H&E and Safranin-O Fast Green, examined and graded by Mankin score. Outcome measurements included: Mean T2* relaxation times at 7T and 3T, CC and OJ thickness measurements from T2*, histomorphometry and Mankin scores.

Results: Mean T2* relaxation times (ms) were lower at 7T (mean: 5.6 ± 3.99) compared with 3T (mean: 7.4 ± 3.4) ($p<0.06$). CC and OJ thickness measured from substracted vTE images were significantly higher at 3T compared with 7T ($p<0.047$).

The correlation between T2* at 7T and OJ thickness was r=-0.629. The correlation between T2* at 7T and CC and OJ thickness measured by substracted vTE images was r=-0.576. Mean Mankin score was 5.5 ± 1.8. The correlation between CC and OJ thickness measured by substracted vTE images and Mankin was r= 0.593.

Conclusions: A decrease of T2* was expected at the higher field strength because magnetic field inhomogeneities and susceptibility effects are much more pronounced at 7T. Seven Tesla vTE sequences showed higher correlation with histomorphometric measurements and Mankin scores than 3T. Three-dimensional vTE sequence on 3T and 7T field strength showed feasibility to precisely assess the osteochondral junction and calcified cartilage in an ex-vivo knee. Since these tissues have a very short T2 relaxation time (~ 5-10 ms), vTE sequences allow accurate calculation of T2* in these challenging tissues.

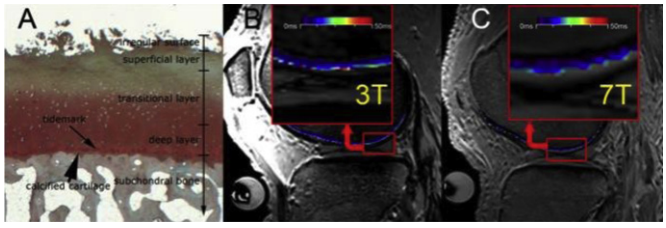

Fig. 1. Sagittal Saf-O stained histological section showing the calcified cartilage (CC) and ostenochondral junction (OJ) or tidemark (A). 3D multi-echo vTE T2* mapping at 3T (B) and 7T (C). T2* shorter relaxation times are visible at 7T compared with 3T.

363
CHEMICAL EXCHANGE SATURATION TRANSFER MR IMAGING OF VISCOSUPPLEMENTATION (VISCO-CEST) AT 7 T: A PRELIMINARY REPORT

M. Haris [†], A. Singh [†], K. Cai [†], J. Kneeland [†], R. Shah [†], J. Carey [†], J. Kelly [†], F. Tjoumakaris [‡], H. Hariharan [†], R. Reddy [†]. [†] *Univ. of Pennsylvania, Philadelphia, PA, USA;* [‡] *Thomas Jefferson Univ. Hosp., Philadelphia, PA, USA*

Purpose: To evaluate the chemical exchange saturation transfer (CEST) effect from the two popular viscosupplements (VS) (Hylan gf-20 (Synvisc) and hyaluronan (Orthovisc)) by exploiting the exchangeable hydroxyl groups present on these molecules at 7T human scanner.

Materials and Methods: For this study, we used two brands of VS i.e. Hylangf-20 (Synvisc, Genzyme Biosurgery) and high molecular weight Hyaluronan(Orthovisc, DePuyMitek). Orthovisc has a lower molecular weight than Synvisc but contains a higher concentration of hyaluronic acid per injection than Synvisc. Both products have already shown their treatment efficacy in reducing pain associated with osteoarthritis (OA) and are considered high molecular weight hyaluronic acid compounds. The CEST imaging was performed on a 7T Siemens whole body MRI scanner (Siemens Medical Systems, Malvern, PA, USA). The experiments were performed at 37 0C using a custom designed Styrofoam chamber to maintain the temperature at 37±1 C during the course of the experiment. The pulse sequence uses a frequency selective saturation pulse train followed by a segmented RF spoiled gradient echo (GRE) readout sequence. The sequence parameters were: slice thickness = 10 mm, GRE flip angle = 10o, GRE readout TR = 8.4 ms, TE = 4.1 ms, field of view = 100 × 100 mm2, matrix size = 192 × 192, and one saturation pulse and 192segments acquired every 10 s. CEST images were collected with different combination of saturation pulse B1rms and saturation duration. Z- spectra were collected at B1rms of 155 Hz and 1s duration by varying the frequency from -4 to +4 ppm in step size of 0.1ppm. The B0 and B1 maps were also gathered. For CEST contrast computation the acquired images were first corrected for B0 and then used to compute the CEST map using equation CEST=100* [(S-ve¬- S+ve)/S0]. Where S-ve¬¬¬ and S+ve are the B0 corrected MR signals acquired while saturating at at -1 ppm, +1 ppm from water resonance, while S0 is the image obtained without application of any saturation pulse. The CEST contrast map was further corrected for any B1 inhomogeneity.

Results and Discussion: The Z-spectra (figure A) and Z-spectra asymmetry (figure B) curves show the broad peak center around 1 ppm in both VS. The Z-spectra asymmetry curve clearly shows higher CEST contrast from Orthovisc compared to Synvisc. The CEST map at B1rms of 155Hz and 1s saturation duration (figure C) clearly depicts ~ 20% higher CEST contrast from Orthovisc. The higher CEST contrast from Orthovisc may be due to its higher concentration of hyaluronic acid compared toSynvisc. Based on our saturation amplitude (B1) and duration dependent studies we found optimal B1rmsof 155Hz and 1s duration to observe the maximum CEST contrast from both molecules in reasonable scan time at 7T. In a previous study, it has been shown that the optimal B1rms and saturation duration to get maximum glycosaminoglycan (gag) CEST contrast from knee cartilage is 93 Hz and 500ms saturation duration. A typical gagCEST image obtained from a healthy human knee at 7T is shown in figure D.

Conclusions: These results show that it is feasible to compute CEST effect from both the VS and human knee cartilage at 7T, and demonstrate the potential of CEST to monitor and track the course of these VS in human jointsin vivo. Furthermore, using the CEST technique with optimal parameters it may possible to map the fate of the injected VS in knee joints of OA patients over time as well as determine their potential disease modifying capacity and effect on knee cartilage gag concentration. Further studies along these lines are currently in progress in our laboratory.

Acknowledgements: This project was supported by the National Institute of Biomedical Imaging and Bioengineering of the National Institutes of Health through Grant Number P41-EB015893.

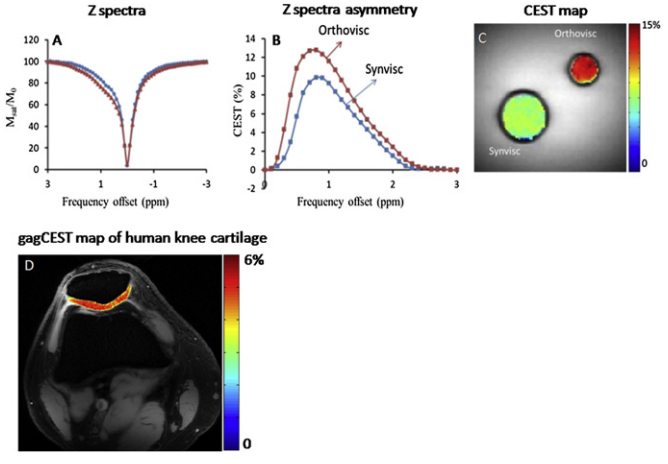

Figure. Z-apectm {A} and Z-spectem asymatry {B} curves from orhtomic and syndic show CEST effect around 1ppn. CEST map {C} shows higher CEST constrast in Orthovisc compared to Symmisc. Figure D shows gagCEST map from a healthy human knee cartilage at 7L.